Cleaner Shared Industrial Growth in East Asia[1]

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[1]The DMEs of East Asia include several low-income countries (China, Cambodia, Lao PDR, Mongolia, Myanmar and Vietnam), a number of middle income countries (Indonesia, Papua New Guinea, the Philippines, Thailand, Malaysia and Korea), and several high-income economies (Hong Kong, Taiwan and Singapore). The argument that follows can easily be extended to South Asia.

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I. Introduction

The purposes of this paper are to outline the dimensions of a historically unique sustainability challenge facing the developing market economies (DMEs) of East Asia and to identify the policies for overcoming the challenge. The hope is that this discussion of the challenge and of policy responses to meet it will initiate a dialogue that mobilizes governments, donors, communities and private enterprises in this region to act now to ensure that future industrial growth is substantially cleaner. This result is labeled cleaner shared industrial growth.

The argument proceeds in four steps. Section II outlines the nature of the sustainability challenge. Section III develops a simple theoretical framework for identifying cost-effective regulatory and non-regulatory policies for cleaner shared industrial growth. Section IV examines, in some detail, the role of regulatory polices in cleaner shared growth. Section V focuses on the specific industrial, investment promotion, technology, and economy-wide polices most likely to contribute to cleaner shared industrial growth. Section VI identifies the implications of the argument for those interested in promoting cleaner shared growth in particular countries and regions in East Asia.

II. The Sustainability Challenge

Rapid urban-based industrial growth, particularly of manufactures, has been at the core of the shared growth model of development pursued by the DMEs of East Asia.[2] With rapid industrial growth came equally rapid urbanization. Because industrialization largely took place in urban areas, cities in the DMEs of East Asia came to account for a disproportionate share of GDP and industrial output.[3] The near coincidence of industrialization with urbanization and “grow now clean up later” environmental strategies meant that industries in cities, also generate most of the pollution load (70% in Indonesia, World Bank, 1994: 80) in the DMEs of East Asia. When this is combined with the burning of dirty fuels for cooking and home heating and rising emissions from cars, trucks, buses and motorbikes, the result is average levels of air particulates in cities approximately five-

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[2] The East Asian NICs are divided into the first tier NICs (Korea, Taiwan, Hong Kong, and Singapore) and the second tier NICs (China, Indonesia, Malaysia, and Thailand). Between 1965 and 1996, value-added in manufacturing in East Asia increased at an average annual rate of 9.7%, more than three times the world average (World Bank 1998a). This is not to denigrate the importance of intensification in smallholder agriculture, or of massive investments in basic education, basic health care, family planning, and in infrastructure, particularly rural infrastructure, to the success of the East Asian shared growth model.

[3] The Bangkok metropolitan region of Thailand accounts for almost one-half of Thailand’s GDP and a little more than 75% of manufacturing value added (World Bank, 1994: 8). Similar, though less concentrated, outcomes appear elsewhere. Four cities on Java (Jakarta, Surabaya, Bandung, and Semarang) account for 36% of Java’s and 27% of Indonesia’s industrial output (World Bank, 1994: 75) while the urban share of industrial production on Java is expected to rise from 55% to 70% by 2010 (WorldBank, 1994: 75). The combination of rapid urban-industrial growth and de facto ‘grow now clean up later’ environmental strategies has

times higher than in the OECD and twice the world average (Asian Development Bank, 1997). Measures of water pollution, such as BOD levels and levels of suspended solids, are also substantially above world averages. This makes cities in the DMEs of East Asia among the most polluted in the world.

These environmental problems also reflect reliance on materials, energy, and water intensive technologies in pollution intensive manufacturing and resource processing industries. Prior to the current crisis in East Asia, energy demand in the DMEs of East Asia was doubling every 12 years and demand for electricity was growing two to three times faster than GDP. One consequence of this is a high and rising energy intensity of GDP. Every kilogram of oil equivalent of energy consumed in high growth East Asia results in only $1.40 of output. This is 40% of the energy efficiency of the U.S. and 15% of the energy efficiency achieved by Japan. There is also evidence that toxic pollution has been growing faster than GDP. The toxic intensity of GDP in Indonesia increased 5.4 times between 1976 and 1984. Comparable figures for Malaysia (3.05 times), Thailand (2.48 times) and Korea (2.5 times) are equally worrying (Brandon and Ramankutty, 1992: 74).

Given this industrial-environmental present, what can be said

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resulted in severe environmental problems.

about the industrial-environmental future of the DMEs of East Asia? Projections of future industrial-environmental outcomes are critically dependent on the scale of projected increases in industrial output. They are also dependent on the geographic concentration of that output, on the composition or industry mix of that output, and on the water, materials, energy and pollution intensity of that output. Because each of these can be influenced by public policy, outcomes are also dependent on policy choices.

While no one has yet developed a comprehensive model to project industrial-environmental outcomes based on assumptions in each of these areas, the broad outlines of the most likely possibilities are now visible.[4] Because many of the DMEs in East Asia are still in the early stages of their industrial revolutions, expected increases in industrial output are enormous.[5] In China, for example, fully 80% (World Bank, 1997: 57) of the industrial stock of plant and equipment that will be in place in 2020 has not yet been built. The comparable figure for Indonesia is 85% (World Bank, 1994:166). What this means is that the next twenty years will most likely see a prodigious expansion

4 The World Bank has modeled some of this, see, for example, World Bank, 1994 and World Bank, 1997). For discussion of urban policies for cleaner shared growth see the paper by Douglass and Ling in this volume.

5This is less so for the higher income (Hong Kong, Taiwan, and Singapore) DMEs.

in industrial activity. In the case of China, industrial GDP is expected to increase by nearly 7% per year between 1995 and 2020 (World Bank, 1997, 30). This means that industrial output will expand from roughly $260 billion in 1994 to roughly $1.5 trillion in 1994 dollars by 2020.

Prior to the current crisis, most researchers predicted increased spatial concentration of industrial production in the DMEs of East Asia in ever-larger urban areas, some significant change in the sectoral composition of industrial production, and modest declines in the energy, materials, water-use and pollution intensities of future industrial output. The net effect of these trends is a projected reduction in some measures of the pollution intensity of industrial output but continued increases in pollution loads and in the use of energy, water and materials. What this means is that without additional policy actions, the DMEs of East Asia will become even dirtier and more polluted and more energy, water, and materials using. The social and economic costs of this could become prohibitive.

III. Policy Choices for Cleaner Shared Industrial Growth

How might public policy be used to promote cleaner shared industrial growth? The underlying theory can best be demonstrated by a simple diagram (figure 1) adapted from Rock (1997a). Let QQ' equal a desired reduction in the pollution intensity of industrial production for a firm, industry (sector), or economy. QQ' might reflect either an absolute reduction in pollution intensity (measured in pounds of pollution per unit of value added) or a percentage reduction in pollution intensity needed to sustain a given level of ambient environmental quality.[6] The left vertical axis measures the marginal dollar cost of reducing pollution intensity (MCA) through traditional post-pollution abatement (end-of-pipe expenditures). The curve MCA as drawn (rising from left to right) reflects the traditional rising marginal cost of abatement associated with increasing reductions in pollution intensity through post-pollution treatment. The right vertical axis measures the marginal dollar cost of reducing pollution intensity by reducing the energy, water and materials use intensities of industrial production.

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[6] If the scale of industrial activity increases, the size of QQ' may have to be expanded to sustain a given level of ambient environmental quality.

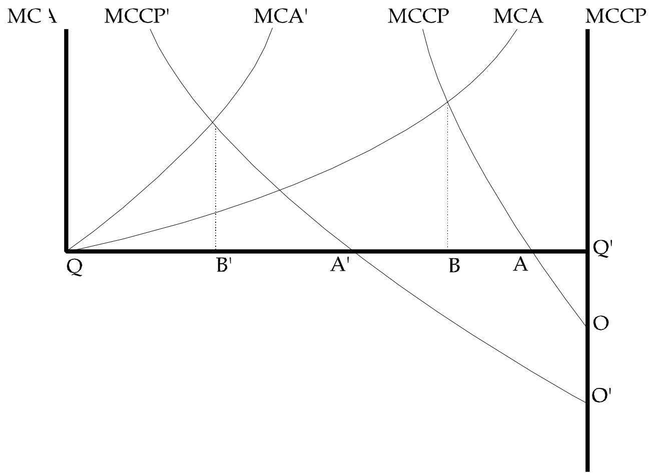

Figure 1

This is often referred to as pollution prevention, cleaner production, or what industrial ecologists call "dematerialization" (Warnick, Herman, Govind, and Ausubel, 1996). This curve is labeled (MCCP) to refer to the marginal cost of cleaner production. It too is reflected in a rising (but from left to right) of the marginal cost of reducing pollution intensity by cleaner production.

There are several important differences between the MCA curve and the MCCP curve. First, to reiterate, MCA reduces pollution intensity by treating pollution after it has occurred while MCPP prevents pollution by reducing energy, water and materials use intensities by substituting less polluting inputs for more polluting inputs, improving energy, water and materials use efficiencies, and recycling energy, water and materials.

Normally, these cleaner production alternatives are brought about by some combination of better "housing-keeping" practices, minor process modifications, or fundamental technical innovation in industrial production processes.

Because of this, reductions in pollution intensity achieved by lowering energy, water and materials use intensities are different from those achieved by abating pollution through end-of-pipe treatment.[7] For one, end-of-pipe treatment is always cost increasing while not all energy, water or materials intensity reduction activities are cost increasing.[8] This is depicted in figure 1 with an MCCP curve with an origin that lies below the zero axis. This part of the curve (represented by OA and area OQ'A) reflects declines in pollution intensity that can be attributed to declining energy, water and materials use intensities that "pay". Second, end-of-pipe treatment is almost always a derivative of environmental regulatory policy. While energy, water and materials intensity reductions can flow from regulatory policy, they can also flow from changes in the relative prices of energy, water and other materials inputs; industrial and investment policies; and the pace, pattern, and

[7]This is particularly important for some pollutants like CO_2 that can simply not be abated by end of pipe technologies.

[8]But not all clean production pays either.

rate of diffusion of energy, water and materials saving technological change. This means that energy, water, and materials intensity reduction need not be driven solely by regulatory policy. As will be argued below, understanding this and appreciating how regulatory and other policies can reinforce these effects is critical to the design of cost effective public polices aimed at reducing energy, water and materials use intensities. One example of this should suffice.

In the context of the DMEs of East Asia, dematerialization and pollution prevention effects that "pay" might well represent declines in energy, water and materials use intensities associated with new (and cleaner) investment. Given the volume of expected new investment relative to the size of the existing industrial capital stock in the DMEs of East Asia, these effects could be substantial. This suggests that governments in East Asia might consider industrial, investment promotion, and technology policies that encourage firms and plants to adopt and rapidly diffuse cleaner technologies.

For heuristic purposes, assume an MCCP given by the curve

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[9] A good example of the diffusion of a cleaner and economically superior technology can be found in Wheeler and Martin (1992).

[10] The World Bank recently estimated that between 1995 and 2010 new investment will account for 85% of total industrial

OAMCCP. With the marginal cost of abatement curve, MCA, the most cost-effective strategy for reducing pollution intensity in a plant, firm, industry, or economy by QQ' requires reductions in pollution intensity through end-of-pipe control by QB and reductions in pollution intensity through energy, water and materials intensity reduction by BQ'. Note that as drawn most of the reduction in pollution intensity comes from conventional end of pipe control.

From a policy perspective, four questions must be asked about this outcome. First, what environmental regulatory policies contribute to this outcome? Second, what role do non-regulatory policies have in promoting this outcome? Third, is the outcome depicted by QB, BQ’ the most cost-effective way to reduce pollution (and energy, water and materials use) intensities? If not, what might an alternative set of cost-effective policies look like (such as that depicted by outcome (QB’, B’Q’) in figure 1)? Each of these is taken up in turn.

IV. Environmental Regulatory Polices

Environmental regulatory policies for cleaner shared growth can best be understood by reference to the environmental

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capacity (Brandon and Ramankutty, 1993: 75).

[11]Note that in this formulation reductions in pollution intensity through reductions in energy and resource use

policies currently in use by countries in the OECD. As depicted in Table 1, those policies either: impose legal limits on emissions from major point sources of pollution, encourage facilities and firms to prevent pollution before it occurs, or reward firms for “superior environmental performance”. In terms of figure 1, policies that impose legal limits on emissions (most often referred to as command and control policies) work on MCA, pollution prevention policies work on MCCP, while policies that reward firms for superior performance affect QQ’.

Until recently, environmental protection agencies within the OECD relied heavily on command and control policies to meet mandated pollution intensity reduction goals such as QQ’ in figure 1. Even now, command and control policies are the base on which pollution prevention policies and superior performance policies rest. How command and control policies promote pollution reduction goals such as QQ’ is fairly well understood. To begin with, they are almost always rooted in comprehensive environmental legislation that vests legal authority in environmental regulatory agencies to protect the environment. Landmark environmental legislation enables environmental protection agencies to set ambient standards and facilities

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intensity are incorporated in the area OQ'A.

specific emissions standards, monitor and report to concerned publics on ambient conditions and on the compliance status of regulated facilities with emissions limits, and to impose penalties on regulated facilities that fail to meet pollution discharge requirements. Without clear legal authorities to do these things, it is virtually impossible for regulatory agencies to define ambient standards and facilities specific emissions standards, clarify expectations for the regulated community, and promote equity in the burdens placed on similar point sources of pollution.

Because ambient air and water quality standards are critical for the protection of public health and eco-systems, environmental protection agencies typically get actively involved in setting ambient standards. Doing this right depends on reliance on “main-stream” science, peer review, and on an open, participatory, and transparent standard setting process that gives major stakeholders input into the setting of ambient standards. Following this, numerical concentration limits can be set for air and drinking water quality and for surface water based on intended uses. Regulatory agencies can complement ambient standards with procedural requirements for handling solid and hazardous wastes. If it is not possible to meet ambient standards without imposing undue hardships on regulated facilities, regulatory agencies can set interim goals with attainable milestones. These interim goals are often reached following arduous consultation and negotiation with the regulated community and the public.

Environmental protection agencies can also take responsibility for monitoring and reporting ambient conditions and changes in them. Reliable information on ambient conditions and changes in them can be an important way for these agencies to generate public and political support for pollution control. Because the public and regulated facilities are usually quite interested in the impact of command and control policies on ambient environmental quality, it is critical that both have sufficient respect for the institutions charged with ambient monitoring. This is obtained by conducting ambient monitoring in accordance with widely accepted professional standards and protocols, and by using reliable monitoring equipment.

In addition to setting ambient standards, regulatory agencies also set facilities specific emissions or discharge limits on major point sources of pollution. While it is recognized that facilities specific discharge limits should be set on the basis of expected impact on ambient environmental conditions, this is difficult to do in practice. Because of this, discharge limits are most often set on the basis of what best available technology can obtain without imposing undue hardships on regulated facilities. Most environmental protection agencies also differentiate between new point sources of pollution and existing sources. Emissions limits for new sources are often more stringent than those for existing facilities.

To ensure facility specific compliance with discharge limits, environmental protection agencies require major point sources of pollution to monitor emissions, record outcomes, report serious violations immediately, and to periodically report compliance information to regulatory agencies and the public. This is often complemented by periodic monitoring by regulatory agencies and by unannounced inspections of regulated facilities. If it is economically difficult for a facility to meet emissions standards, regulatory agencies can offer compliance assistance and work out formal compliance schedules with regulated facilities that bring them into compliance over time.

Since environmental protection agencies are legally entrusted to ensure that the regulated community is in compliance with established emissions limits, facilities found to be in substantial violation of discharge standards are subjected to a range of sanctions designed to enforce compliance. Thus regulatory agencies routinely issue administrative warnings, order improvements, suspend operations, and occasionally shut down operations of facilities found to be in persistent violation of emissions standards. They also rely on the courts to try and impose civil and/or criminal penalties.

Available evidence (World Bank, 1992:) suggests that these command and control policies are highly effective at de-linking growth from environmental degradation. They also contribute to notable improvements in ambient environmental quality. Despite this success, technology-based standards have not been sufficient to meet desired ambient standards. This is not the only criticism of technology-based command and control regulatory policies. Economists argue that these policies ignore efficiency considerations in the way facilities met emissions limits. The regulated community has echoed this view and has complained that command and control policies impose onerous administrative burdens on regulated facilities and result in heavy-handed use of enforcement discretion by regulators. More recently, the regulated community has opined that increasingly stringent emissions limits impose high costs on regulated facilities (that is, they are forced to operate very high up on the steepest part of the MCA curve in figure 1) while yielding small or insignificant improvements in ambient environmental quality. Others have criticized command and control policies for emphasizing the cleaning up of pollution after it occurs rather than preventing it in the first place (that is, failing to recognize the MCCP curve in figure 1). Still others have criticized command and control policies for failing to reward firms for “beyond compliance” performance (that is, failing to recognize that some leading firms may be willing to go beyond reductions in emissions level QQ’ in figure 1).

Because of these criticisms, regulatory agencies in the OECD began experimenting with “market-based policy instruments”, pollution prevention policies, and “superior performance” policies. These new policies were complements to, not substitutes for, the basic command and control policies that essentially required major point sources of pollution to abate pollution by investing in end of pipe pollution control equipment (the MCA of figure 1). The major impact of this shift in regulatory policy was that regulated point sources were given greater flexibility in how they met required reductions in emissions (QQ’ in figure 1). Market-based instruments were designed to take efficiency considerations into account in the meeting of emissions standards. In terms of figure 1, market-based instruments were designed to lower and move the MCA curve to the right. In the case of tradable permits, this was accomplished by allowing high marginal cost of abatement facilities to purchase the right to increase emissions above emissions requirements from lower marginal cost of abatement facilities. The net effect of trades in permits to emit was that overall reductions in emissions (QQ' in figure 1) were met at lower abatement cost (the overall MCA curve in figure 1 shifted down and to the right). Other market-based instruments include pollution charges, performance bond schemes, and deposit-refund systems. While attractive in terms of gains in economic efficiency, in practice, the effective use of market-based instruments has been limited. In the U.S., market-based instruments have been successful in reducing lead in gasoline and in reducing sulfur dioxide emissions from large power plants.[12]

Unlike traditional regulatory programs and market-based instruments that work on the marginal cost of abatement (MCA) in figure 1, pollution prevention policies encourage point source facilities to prevent pollution before it occurs. That is, they impact the marginal cost of cleaner production or MCCP in figure

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[12]Excellent reviews of the strengths and weakness of such approaches can be found in Stavins and Portney Public Policy for Environmental Protection (nearing publication) and Environmental Policy Tools a 1995 publication of the U S Congress, Office of Technical Assessment.(add as references)

1. The ultimate goals of pollution prevention policies are to avoid or reduce the quantity and toxicity of waste streams and to reduce or eliminate the need for end of pipe treatment. While the initial focus of pollution prevention policies was on small batch-type production processes that resulted in especially toxic wastes, over time pollution prevention policies have been expanded to deal will all types of interventions designed to reduce pollution and conserve energy, water, and raw materials.

In the U.S., this approach was incorporated in the Pollution Prevention Act of 1990. Among other things, the Act postulated a hierarchy for waste reduction activities including: (1) process changes to limit or reduce the toxicity of the waste streams; (2) reuse of raw materials; (3) recycling of process streams and (4) finally, if all else fails, complete treatment prior to disposal. Pollution prevention policies also sparked collaborative efforts between industry specific trade associations and regulatory agencies to find less costly ways to meet tighter emissions standards. This proved to be important as more stringent emissions requirements significantly raised the unit costs of abatement. Because there was some evidence that pollution prevention activities “paid”, as depicted by the area

OAQ’ in figure 1, by actually reducing costs of production and by reducing or eliminating the costs of abatement, they came to be seen as potentially attractive alternatives to cleaning up pollution after it occurred.

Advocates of policies for pollution prevention or cleaner production have argued that because of information, policy, market, and coordination failures in clean technology markets, the outcome (QB, BQ’) depicted in figure 1 is not cost effective. They argued that markets failed to convey to polluters both the real lower marginal cost of clean production (denoted by the lower cost O'A'MCCP' curve) and the real higher marginal cost of abatement (denoted by the higher MCA' curve). If the real costs of a cleaner production environmental management strategy are given by the O'A'MCCP curve and the real marginal cost of abatement curve are given by MCA', several important differences result. First, the range of pollution prevention or energy, water and materials intensities reduction activities that pay expands from area OAQ' to area O'A'Q'. This provides more win-win opportunities for polluters. It may also convey Porter-like "competitive" advantages to firms that shift in this direction (Porter and Class van der Linde, 1995). Second, cost effective pollution reduction requires more clean production (an increase in energy, water and materials intensities reduction from B to B') and less end-of-pipe expenditure (a reduction from B to B'). Third, except in the case where the real O'A'MCCP' is less than the real MCA' for all levels of pollution reduction, firm and plant level cost-effective industrial-environmental management requires identifying the optimal combination of end-of-pipe and clean production.

But why might existing policies and market forces generate pollution intensity reduction outcomes like QB and BQ' rather than the more cost-effective outcome given by QB' and B'Q'? There are two answers to this question. First, traditional 'command and control' technology based industrial-environmental management systems favor end-of-pipe pollution intensity reduction strategies over clean production strategies. Because technology based standards underlying existing 'command and control' industrial-environmental management systems identify the range of pollution intensity reduction possible with best available end-of-pipe technologies, they are easier and less risky for both regulators and polluters. This biases pollution intensity reduction strategies in an end-of-pipe direction. If this bias is combined with increasingly stringent emissions standards, this provides incentives for the end-of-pipe pollution control industry to search for cost reducing end-of-pipe technological change. In terms of figure 1, this has the effect of pushing MCA' down and to the right. The use of market-based instruments reinforces this shift. Assuming no change in O'A'MCCP', this biases cost-effectiveness toward more pollution intensity reduction by abating pollution after it has occurred.

If, in addition, markets for cleaner production are characterized by information and coordination failures and/or high risks and high transactions and learning costs, O'A'MCCP' may be higher and to the right of the existing O'A'MCCP' curve in figure 1. This reinforces the end-of-pipe policy bias. But why should clean production markets be characterized by information and/or coordination failures or high risks and high transactions and learning costs?

There are several answers to this question. To begin with, implementing a firm or plant level clean production industrial-environmental management strategy raises several new problems for manufacturing firms and plants. Several examples should suffice to demonstrate this. Substitution of a less toxic input for a more toxic input may either be perceived to be or actually change the quality of the final product (Laughlin and Corson, 1995:11). Even though it might pay to make this substitution, firms may be unwilling to take the risk of a negative customer reaction to this 'new' final product. The same might be said about basic process modifications that "pay". In addition, before firms make these switches, they may have to invest scarce managerial and engineering time and even scarcer capital to identify clean production alternatives (Kiesling, 1994:15). Unless these expenditures have known or expected payoffs that are better than the alternatives, firms may be reluctant to make them (Panayotou and Zinnes, 1994). That is, it may simply be prudent to stick with well-known end-of-pipe abatement alternatives.

If current 'command and control' policies, including use of market-based instruments, bias industrial-environmental management strategies in an end-of-pipe direction and if risks, information failures, and transactions and learning costs undervalue the benefits of clean production alternatives, governments can intervene to correct these policy and market failures. This is precisely what regulatory policies that promote cleaner production do. Information, technical assistance, and demonstration projects about pollution prevention opportunities are designed to overcome information failures. Tax breaks, such as accelerated depreciation for cleaner production investments, and subsidized loans are meant to “level the playing field” between pollution abatement alternatives and cleaner production alternatives for reducing pollution, energy, and materials use intensities. They are also meant to compensate firms for the risks and learning costs associated with cleaner production alternatives. If these programs are successful in overcoming policy, market and information failures, and high transactions and learning costs; the real marginal cost of abatement in figure 1 will be given by MCA’ and the real marginal cost of cleaner production in figure 1 will be given by O’M’CCP. With this, more pollution intensity reduction occurs by reducing energy, water and materials use intensities and less occurs by abating pollution after it has occurred.

The third column in Table 1 describes the characteristics of regulatory policies that champion “superior environmental performance” by leading firms that voluntarily commit to pollution reductions that exceed the sum of regulatory restrictions on facility emissions (In terms of figure 1, this means that emissions reductions are larger than QQ’.). In most instances, the chief incentive offered by regulatory agencies is some form of public recognition for credible beyond compliance performance. When environmental reputation matters, public recognition can spur senior management of large, leading, and highly visible firms towards superior performance.

IV. Non-regulatory Policies for Cleaner Shared Growth

Several researchers (World Bank, 1997; World Bank, 1994; and Wheeler and Martin, 1992) have suggested that newer industrial plant and equipment developed within the OECD tends to be cleaner than existing industrial plant and equipment in East Asia. Because manufacturers in East Asia are dependent on firms in the OECD for plant, equipment, and technology, it may be technically and economically possible for them to import, adopt, adapt, modify, and innovate on an industrial capital stock that will be cleaner simply because it is newer. Given the expected increase in the size of the industrial capital stock in East Asia over the next twenty years, this could be an important avenue for cleaner shared industrial growth. Some (World Bank, 1997) have suggested that because of the openness of countries in this region to trade, foreign investment, and foreign technology this will happen almost automatically.[13]

What are the implications of this possibility for a cost-effective cleaner shared industrial growth outcome such as QB', B'Q depicted in figure 1? There are two answers to this question. If openness is sufficient to promote a cleaner industrial capital

13 The World Bank (1997 and 199?) have suggested that access to cleaner plant and equipment in Indonesia and China should lead an industrial capital stock twenty years from now that is 25% to 30% cleaner.

stock, the effect of openness will be to push OMCCP in figure 1 down and to the left so that it moves toward O'MCCP'. This results in more pollution intensity reduction through energy, water, and materials reduction and less through post-pollution abatement. This suggests large win-win effects for the environment and the economy.14 But it is important to ask if this possibility is inevitable or whether it is dependent on other policies. If it is dependent on other policies, it is important to identify those policies.

There are several reasons to suspect that openness, by itself, may not be sufficient to generate win-win outcomes like QB', B'Q in figure 1. First, win-win outcomes such as QB', B'Q' in figure 1 will be less likely the more "new" investment consists of older and dirtier industrial capital. Second, win-win outcomes will be less likely if policies elsewhere in the economy discourage efficient use of energy, water and materials. And, third, as will be argued below, even if new investment is cleaner and resource pricing policies are efficient, unless firms have the capacity to manage plant and equipment efficiently, they may not be able to achieve cost-effective pollution intensity outcomes represented by QB', B'Q' in figure 1.

14Win-win effects for the economy are manifest in the larger area of gain (O'A'Q') in pollution prevention that pays.

What do we know about each of these? To begin with, there is little doubt that some of the “new” investment in the second (Indonesia, Malaysia, Thailand and the Philippines) and third (China, Cambodia, Lao PDR, and Vietnam) tier newly industrializing countries (NIEs) of East Asia consists of older and dirtier capital in sunset industries. Several of the first tier NIEs (Korea, Taiwan, and Singapore) have encouraged the export of low technology labor-intensive industries such as textile dyeing, leather-making, and simple electro-plating to China, Indonesia, Malaysia, and the Philippines. Some (Rock, 199?:)have suggested that this is the natural outcome of shifting comparative advantage. This suggests that openness alone might just as easily promote dirtier industrial outcomes. This tendency can be and has been exacerbated by inappropriate pricing policies for energy, water and other materials in some of the NIEs. Sometimes, as in China, energy price policy favors dirty over cleaner fuels. Sometimes, as in Indonesia, energy prices are kept well below international prices. Similarly, water and other materials (such as wood and primary metals) are also often under-priced.

How do the import of older and dirtier capital equipment and the under pricing of energy, water and materials affect the pollution intensity reduction outcomes depicted in figure 1? The import of older and dirtier capital equipment has at least two effects. On the one hand, it forces firms and plants to rely on end of pipe treatment (the MCA in figure 1). It may also provide opportunities for plants to engage in better-housekeeping practices and minor process changes that reduce energy, water and materials use intensities (the MCCP in figure 1). But how much of each of these plants engage in will depend on the degree to which regulatory policies encourage both end of pipe treatment and cleaner production. It will also depend on energy, water, and materials price policies. If regulatory policies emphasize end of pipe treatment (MCA in figure 1) and energy, water and materials price policies discourage efficient use of energy, water and materials, outcomes will look more like QB, BQ’ in figure 1 rather than QB’, B’Q’. But if regulatory policies encourage clean production alternatives, as well as end of pipe treatment and energy, water and materials prices reflect at least international prices, pollution intensity reduction could move more toward outcomes like QB’, B’Q’ in figure 1.

That being said, before industrial plants and firms in the DMEs of East Asia can take advantage of either end of pipe or cleaner production opportunities they must have the capability to efficiently manage plant, equipment, technology, technical change (especially technology acquisition), and technical know-how. If industrial firms lack the capability to do these things, there may be significant limits to their ability to respond to regulatory, economy-wide, and industrial policy incentives designed to push them in a direction that lowers pollution, energy, water, and materials use intensities. Lack of capabilities in these areas might also limit the ability of firms to take advantage of new imported technologies that are cleaner.

What do we know about the capabilities of firms in the DMEs of East Asia to manage production efficiently, to improve production capabilities, and to carry out technical change? There are several answers to these questions. First, there is enormous variability in the existing capabilities of firms to do this well (Roberts and Tybout, 1996; Kim, 1997; Hill, 1996; Rock, 1999). This capability varies by country, firm size, by sector, and by ownership. Firms in Northeast Asia appear to be better at this than their counterparts in Southeast Asia (Kim, 1997 and Hill, 1996). Large firms appear to be better at this than small firms (Lall, 1992: 169). This is easier for firms to do in supplier dominated capital goods sectors (textiles) than it is to do in either scale intensive sectors (automobiles or

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[15] It might also limit their ability to adapt new imported technologies embedded in "new" investment that is more rather than less pollution, energy and/or materials intensive.

aircraft) or science-based sectors (such as chemicals or electronics where a strong capacity for reverse engineering is needed) (Bell and Pavitt, 1992: 265). Firms engaged in joint ventures with large foreign firms appear to be better at this than domestically owned firms (Harrison, 1996: 167-173).

Second, because much of the acquisition of these capabilities is tacit, that is it can only be gained from direct experience, variability also depends on a firm's willingness to invest in learning by doing in each of these areas (Bell and Pavitt, 1992: 262). There appears to be enormous variability in the willingness of firms to make these learning by doing investments. Moreover, this willingness is strongly influenced by country policies. A stable high growth environment appears particularly conducive to firms' willingness to invest in technological capability acquisition (Lall, 1992: 169). Export oriented industrialization policies that require firms to reduce costs, raise quality, and introduce new products (Lall, 1992: 169) help. When trade policy is tethered to lucrative export incentives, it can be a powerful stimulus to technical capability building within firms (Rhee, Ross-Larson, and Pursell, 1984 and Kim, 1997). State policies that favor and reward local firm technical capacity acquisition over reliance on foreign capital (direct foreign investment), can and have reinforced these effects (Mardon, 1990).

Third, because there are significant externalities in the accumulation of production, technology, and technology capabilities, government policies are needed to speed the process by which firms acquire new technical capabilities and diffuse them throughout the economy. Experiences in Northeast Asia suggest that two distinct sets of issues affect the speed with which firms acquire new technical capabilities. The first concerns the influence of government policy on firm size. The second concerns the need for government to invest in the provision of public goods that speed acquisition of technical capabilities in industrial firms.

With respect to the size of firms, two distinct patterns have emerged. In the Republic of Korea, one aim of government policy was to promote the development of very large firms (chaebols) that could internalize, and hence appropriate, many of the externalities associated with technological learning (Lall, 1992: 176 and Jones and Sakong, 1980). When this was combined with stable and high growth, an export orientation, and an administrative structure that rewarded performance, the consequences for technical capabilities acquisition were enormous (Kim, 1997). Government support for the development of equally large industrial conglomerates in Indonesia, Thailand

and Malaysia suggests that something similar may be at work in those countries (McVey, 1992 and Rock, 1995, and Rock, 1999). There is one other benefit to government policies promoting the development of large diversified industrial conglomerates. Some of those firms are likely to become leading firms. As experience in the OECD shows, leading firms appear to be particularly susceptible to incentives designed to reward superior performance (i.e. to get them to reduce pollution, energy, and materials intensities by more than QQ’ in figure1).

Alternatively, in Taiwan, industrial development policy promoted the development of a large number of small firms (Wade, 1990). Because no one of these in any industry was capable of internalizing the externalities associated with all facets of acquisition of technical capabilities, much of this was done either in government funded industrial technology research institutes or in public-private sector programs coordinated by governments (Lall, 1992: 176 and Wade, 1990). When this happens, it is not surprising that the public sector rather than the private sector takes the lead in clean production and superior environmental performance.

Beyond this, public sector investments in national technical capability building also matter. As the experiences of Korea and Taiwan demonstrate, large investments in literacy, in secondary education, and in tertiary education, particularly engineering training, make it easier for firms to acquire technical capabilities (Tan and Batra, 1995: 1 and 7). A technology infrastructure that provides information (including information on cleaner technologies); tests materials, inspects and certifies quality control standards (including ISO 14000); and calibrates measuring instruments (Tan and Batra, 1995 facilitates acquisition of technical capabilities particularly in SMEs.

What are the implications of all of this for the pace and scale of diffusion within and between firms in the DMEs of East Asia of production and technological capabilities in pollution, energy, water, and materials intensity reduction? There are three answers to this question. First, policies that promote firm level technical learning and capabilities acquisition are likely to be good for pollution, energy, water, and materials intensity reduction. They should make it easier for firms to engage in better housekeeping practices and minor process innovations that prevent pollution. They should make it possible for firms to "stretch" existing plant and equipment by substantially modifying it to reduce pollution, energy, water and materials use. They should also make it easier for firms to evaluate the pollution, energy, water, and materials intensity of "new" imported plant, equipment, and technology. Each of these lowers (shifts to the left) the marginal costs of cleaner production (MCCP) and contributes to more pollution intensity reduction by increasing energy, water, and materials use efficiencies.

Second, because pollution, energy, water, and materials intensity reduction is or will be a relatively new activity for industrial firms in the DMEs of East Asia, industrial firms there are likely to need industry and technology specific information (and specialized technical training) on how to do this. This is just the kind of information and specialized training that institutions that are part of the national technology infrastructure (such as industrial technology institutes or standards agencies) are good at providing. They should be encouraged to provide such information and training to overcome information failures and the high transactions costs associated with reducing pollution, energy, water, and materials intensities. This is most likely to be true for small and medium sized enterprises (SMEs). Third, existing SME/multinational corporation linkage programs aimed at technological upgrading of SMEs might well be modified to include MNC "greening" the supply chain programs (Battat, Frank, and Shen, 1996).

V. Summing Up and Next Steps

Our arguments suggest that getting policies right in three discrete but overlapping policy arenas--in environmental policy, in trade and resources pricing policies, and in industrial, investment promotion, and technology policies-- are critical to the success of cost-effective pollution, energy, water, and materials intensity reduction. How might individual economies and sub-regions, such as ASEAN, in East Asia use these insights to design and implement cost-effective pollution intensity reduction policies? To begin with, virtually all of these economies can gain by pricing energy, water, and materials closer to their real scarcity values. They can also gain by removing distortions and allowing prices for these inputs to move closer to traded or international prices. Each of these economies can also gain by maintaining and increasing openness to trade, foreign investment, and foreign technology and by policies that encourage firms to engage in high speed technological learning an capabilities building. Public investments in national technological capabilities building and incentives that reward individuals firms for engaging high-speed technological learning should also help firms move toward cost-effective pollution intensity reduction. Beyond this, policies need to be tailored to take advantage of differences in existing conditions in each of the economies of East Asia.

At least three patterns of differences are visible. One group (Korea, Taiwan, Hong Kong, and Singapore) of economies has relatively strong command and control environmental agencies, economies that are nearing the end of their industrial revolutions, and firms with strong technical capabilities. A second (China, Indonesia, Thailand, Malaysia, and the Philippines) group of economies has much weaker environmental protection agencies, economies that are in the midst of their industrial revolutions, and firms with weaker technical capabilities. A third group (Cambodia, Laos PDR, and Vietnam) of economies has extremely weak environmental protection agencies, economies that are at the beginning of their industrial revolutions, and firms with extremely limited technical capabilities.

Economies in the first group (Korea, Taiwan, Hong Kong, and Singapore) face four problems/opportunities. To begin with, economies in this group are nearing the end of their industrial revolutions. This means that pollution, energy, water, and materials intensities are likely to grow less fast than income. It also means that most of the industrial capital stock that will be in place twenty years from now is already in place. Because of this and because economies in this group have relatively successful command and control environmental agencies, clean-up is either just about complete (as in Singapore) or well on the way to being completed (Korea and Taiwan).

Moreover, because environmental agencies in this group of economies are command and control oriented, pollution intensity reduction has been biased in an end of pipe direction. In terms of figure 1, this means that the burden of pollution intensity reduction has been put on MCA. As we know from experiences in the rest of the OECD, there are rapidly diminishing returns to this strategy. As ambient environmental standards and facilities specific emissions standards are tightened, firms in these economies will be forced to move further up the marginal cost of abatement curve (MCA). This will undoubtedly create pressures, as it did within the OECD, on regulators to “ease up” on the regulated community. Because of the close relationship between business and government in these economies, this could contribute to regulatory reversals. To counter this, regulatory agencies in this group of economies need to develop market-based instruments, pollution prevention, and superior performance complements to command and control policies. This means that regulatory agencies in these economies are likely to be particularly open to policy initiatives that work on MCCP in figure 1 (prevent pollution) and expand QQ’ beyond what regulations require (reward superior performance). Regulatory agencies in these economies also need to develop stronger relationships with and more support for their actions with political leaders, the public, and the regulated community. This may be necessary to prevent regulatory backsliding. Because publics, communities, and environmental NGOs in this group of economies tend to be distrustful of governments, this may not be easy to do.

Because firms in this group of economies have made a habit of engaging in high-speed technological borrowing and learning, it should be relatively easy for them to engage in high-speed technological borrowing and learning in environmental management. Tough, competent regulatory agencies have, no doubt, already contributed to this, at least with respect to end of pipe solutions to pollution. Now is the time to extend firm level learning to cleaner production and superior performance solutions to pollution. How this might best be done is likely to vary by country. In Korea, where large vertically integrated and conglomerated firms dominate, much of the new learning is likely to take place within the firm. Thus policies designed to promote technical environmental learning in cleaner production and superior environmental performance must take account of this. One way to do this is by linking corporate leaders and environmental management units in these large firms with their counterparts in “leading” firms in the U.S. In Taiwan, where small firms dominate, the public sector is likely to be the primary conduit for learning about cleaner production and superior performance. This requires working with industrial policy agencies (such as the Industrial Development Board of the Ministry of Economic Affairs), science and technology institutes (such as the Industrial Technology Research Institute) and standards agencies.

Finally, governments in several of these economies (particularly Korea, Taiwan, and Singapore) are actively engaged in selective industrial policies that promote the development of indigenous environmental goods and services industries. In each instance, nascent domestic environmental goods and services industries are expected to become export-oriented. In some economies (Korea and Taiwan), government agencies expect this industry to capture a significant share of the market for environmental goods and services in countries such as Malaysia, Thailand, Indonesia, and the Philippines. It would be unfortunate if firms in this industry in these economies end up successfully promoting and exporting only end of pipe solutions to pollution. To avoid this bias toward end of pipe solutions, efforts should be made to ensure that capabilities building in this nascent industry in these economies includes learning about cleaner production and superior performance policies

Economies in the second group face more difficult tasks. For one, their environmental regulatory agencies are much weaker. In some economies (Thailand and the Philippines), these agencies operate without landmark environmental legislation that empowers them to set ambient and emissions standards, monitor performance, and enforce compliance. In others (Indonesia and Thailand), regulatory agencies have no authority to monitor, inspect, or enforce facilities specific emissions standards. In virtually all of these economies, regulatory agencies lack both sufficient technical capacity and sufficient resources to effectively manage national environmental protection programs. Weaknesses in environmental protection programs are exacerbated by the looming sustainability challenge outlined in section II. Because the economies in this group are in the midst of their industrial revolutions, they are poised for substantial and massive increases in industrial output over the next twenty years. This combination of weak environmental protection agencies and large expected increases in industrial output is particularly noxious.

What can/should governments do under these circumstances?

First and foremost, substantial efforts must be made to enhance the capacity and capabilities of environmental protection agencies to set, monitor and enforce facilities specific emissions standards. Experiences in Singapore, Korea, Taiwan, and within the OECD suggest that this will take time and resources. In Singapore, Korea, Taiwan, and in the OECD more broadly, this required building the capacity and capabilities of environmental protection agencies to implement and manage traditional command and control policies (as depicted in column 1 in table 1). Only after this was done, did regulatory agencies introduce pollution prevention (column 2 of table 1) and superior performance policies (column 3 of table 1). This raises an interesting question. Should the nascent environmental protection agencies in this group of economies follow this path or should they try to simultaneously develop command and control, pollution prevention, and superior performance policies? Or should they attempt even more innovative alternatives such as integrated pollution control? Since pollution prevention policies and superior performance policies are complements to and not substitutes for sound command and control policies, we suspect that environmental protection agencies in this group of countries would be best served by developing the capacity to manage rigorous command and control programs.

What might these agencies do in the interim while command and control capacities are being built? There is a simple and straightforward answer to this question. Environmental protection agencies need to be both opportunistic and strategic. That is, they need to look for opportunities where they can intervene to make a difference and where they can learn by doing. This suggests taking a problem specific approach to capacity and capabilities building. This can mean taking action that either builds on or galvanizes public opinion and/or community pressure. There are several examples in East Asia of how this has already been done. The Department of the Environment in Malaysia (Vincent, 1997) took advantage of growing community and public dissatisfaction over unabated pollution from crude palm oil mills to fashion a highly effective intervention strategy that successfully de-linked palm oil production and exports from water pollution. This included development of a highly productive relationship with a quasi-public quasi-private science and technology research institute. A local environmental agency in Indonesia (Aden and Rock, forthcoming) did much the same when it used a highly publicized pollution case to mount a small-scale monitoring and inspection program that worked. Indonesia's national environmental impact agency, BAPEDAL, has gone one step further by developing a simple environmental business rating program, PROPER, (Afsah and Vincent, 1997) that relies on public disclosure and shame to get plants to clean-up pollution.

The export-orientation of firms in these economies opens an additional opportunity for strategic intervention. There is growing evidence that external environmental market pressure can influence the environmental behavior of manufacturing plants that export. Sometimes this takes the form of greening the supply chain programs, sometimes it takes the form of international voluntary environmental standards (such as ISO 14000), and sometimes it take the form of industry codes of conduct (such the chemical industry’s Responsible Care program). Nascent environmental regulatory agencies in this group of countries can take advantage of the opportunity created by the export orientation of industry by working with industrial policy agencies (ministries of industry, science and technology institutes, and standards agencies) that provide assistance to local firms so they can meet these requirements. This might take the form of cooperation between an environmental protection agency and a national standards agency on development of policies for ISO 14000 certification of local firms. It might take the form of adding an environmental supply chain program to linkage programs between local small and medium enterprise suppliers and multinational buyers. Or it might take the form of development of a green labeling program between environmental protection agencies and respected domestic environmental NGOs.

There are three potential advantages to these kinds of partnership programs between environmental protection agencies and industrial policy agencies. Because they place some of the implementation burden on others, they limit demands on nascent environmental protection agencies. They also encourage productive relationships between environmental protection agencies and industrial policy agencies. This can work to the benefit of the latter, particularly as the former learns that they can help their clients meet some of the external environmental demands they face. Finally, they actively engage industrial policy agencies in environmental protection.

Countries in the last group (Cambodia, Laos PDR, and Vietnam) face the most formidable challenges. These economies are largely agrarian, they have very small industrial bases, and they have even smaller export-oriented industrial bases. Their current comparative advantage in industry is in low-skill, low-wage, labor-intensive dirty industries such as textile dyeing, leather-making and low-skills electro-plating. These are relatively footloose industries and the very industries that others in East Asia, particularly Korea, Taiwan, Singapore and Hong Kong are losing comparative advantage in. Because of this loss of comparative advantage, many of the “plants” in this industry are relocating to this third group of countries. Plants in this industry are also moving to other low wage countries such as India, Bangladesh, and Sri Lanka.

Comparative advantage in these dirty industries, high levels of poverty, low levels of education, and great weaknesses in institutional capacity in government generally and in environmental protection in particular provide few obvious opportunities for effective intervention. Countries in this group might have much to gain from a regional (ASEAN-based) investment code of environmental conduct that binds foreign investors to a commonly agreed upon set of environmental practices. This could be particularly helpful if foreign investors from elsewhere in East Asia and from elsewhere in the OECD abided by a set of environmental requirements similar to those of investors’ home countries or economies. Export-oriented industrial plants in these countries might also gain from greening the supply chain programs and other external environmental market pressures (such as 14000 certification and green labeling programs, particularly if they are managed either by foreign investors or donors.

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